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ABSTRACT

Most comparative studies about China were challenged by many sinologists and educators for not grounding on representative samples. This research is mainly based on a Chinese data base collected from a random sample of more than 10,000 9th-grade students in the Second International Association for the Evaluation of Educational Achievement (IEA) Science Study (SISS) Extended Study (SES), a key project supported by the China State Commission of Education in the late 1980s. In contrast, the U.S. student data collected by the same IEA SISS instrument were appended to the SES data base. Analyses of the empirical data uncovered no significant difference in science achievement between the Chinese and American students. Given the fact that sizes of the representative samples in both countries were large and the difference of student achievement was still insignificant, this empirical result seemed to disconfirm the assertion of Chinese outperformance claimed by many scholars. Factors behind the disconfirmation are many, including significant regional differences in China, as well as different school investments in urban and rural communities. Contains 21 references. (Author/MKR)

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An Empirical Study of Student Science Achievement in the People's Republic of China*

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An Empirical Study of Student Science Achievement in the People's Republic of China

Abstract

Most comparative studies about China were challenged by many sinologists and educators for not grounding on representative samples. This research is mainly based on a Chinese data base collected from a random sample of more than ten thousand 9th grade students in a SISS Extended Study (SES), a key project supported by the China State Commission of Education in the late 1980s. In contrast, the U.S. student data collected by the same IEA SISS instrument were appended to the SES data base. Analyses of the empirical data uncovered no significant difference in science achievement between the Chinese and American students. Given the fact that sizes of the representative samples in both countries were large and the difference of student achievement was still insignificant, this empirical result seemed to disconfirm the assertion of Chinese outperformance claimed by many scholars. Factors behind the disconfirmation are many, including significant regional differences in China, as well as different school investments in urban and rural communities.

An Empirical Study of Student Science Achievement in the People's Republic of China

Nurtured almost one fourth of the human beings, China has been one of the most interesting countries in international studies. Cross and Price (1987) pointed out:

> China is a particularly apt choice for study. With major contributions to world technology and pre-modern science over more than two and a half millennia her history commands attention. Today her 1.2 billion people are being urged to modernise through selected borrowing of foreign high technology. Changes which occurred over some two hundred years elsewhere are being compressed into a few decades. (p. 29)

Cleverley (1991) concurred:

> The outcomes of the modernisation of China's education system are of immense international importance. Its regular schools and universities contain some 177 million students -- a significant percentage of the world's young people -- whose talents and skills will take China into the 21st Century. In these times of global interdependency, these young people must be considered a world resource, as well as a national one. (p.1)

Since the beginning of 1980s, several comparative studies have been conducted in the People's Republic of China (P.R.C.) to assess student educational achievement, especially in the area of math and science. According to Torney-Purta (1990), these major undertakings were carried out by the International Association for the Evaluation of Educational Achievement (IEA), the International Assessment of Educational Progress (IAEP), and a group of professors at the University of Michigan and the University of Chicago. To date, among the most recent studies reported to the public are: the Second IEA Science Study (SISS) conducted in the mid eighties (Keeves, 1992; Postlethwaite & Wiley, 1992; Rosier & Keeves, 1991); the second International Assessment of Educational Progress (IAEP) completed in 1991 (Lapointe, Askew & Mead, 1992); and a set of publications developed by Harold W. Stevenson and his colleagues at the University of Michigan and other institutions

(Stevenson & Stigler, 1992). Torney-Purta (1990) further noted:

> Although newspaper headlines have reported the major findings of these international studies, the details of methodology of the actual research have not been published in sources widely read by the educational research community. ...
> In the 1990s it seems likely that these studies will take on greater importance in the educational debate, and researchers who themselves have never participated in comparative research will need to have an informed opinion about them. (p. 32)

A common methodology problem of these comparative studies about China is hinged on the student sample design. China is a large country which has no readily available list of school enrollments. Development of such a list is an indispensable step toward achievement of a random student sample. So far, no such step has been taken in the aforementioned major studies. This major inadequacy was acknowledged in the IAEP public reports (Lapointe, Askew & Mead, 1992). For the same reason, the Second IEA Science Study (SISS), a study involved twenty-two countries and three large Chinese cities, Beijing, Tianjin and Taiyuan, was entitled as a "SISS Pilot Study" in China (Rosier & Keeves, 1991). In contrast, Stevenson and his colleagues employed an accessible student sample in Beijing to represent the general situation in China without further acknowledgement of the Chinese rural population (Stevenson, 1992). All those aforementioned studies indicate that American students have not done better than their Chinese peers in science or mathematics (Lapointe, Askew & Mead, 1992; Postlethwaite & Wiley, 1992; Stevenson, 1992). Limited by the scope of sampling, this empirical assertion is being challenged by many scientists, sinologists and educators who are interested in comparative studies (e.g., Hoffmann, 1989; Rotberg, 1990 & 1991; Wang & Staver, 1994). Lin (1993) pointed out:

> Nine hundred million Chinese people reside in the rural areas, comprising more than 80 percent of the total population in China. Despite this fact, rural Chinese education

> has been among the most ignored areas in educational funding, teacher preparation, research efforts, and access to equal education and employment opportunities. (p. xiii)

Thus, Chinese student achievement may have been over-estimated in the previous studies due to the limitation of unrepresentative urban samples.

The purpose of this research is to exam the allegation of over-estimation through an analysis of empirical data from the SISS Extended Study (SES), a project coordinated by the China IEA Center in the late 1980s. SES is the only nation-wide project in which a systematic population investigation was conducted and a comprehensive list of school enrollments was developed for a systematic sample design. As a key project supported by the China State Commission of Education in the late 1980s, the SES survey covered a random sample of more than ten thousand 9th grade students from urban, sub-urban, and rural areas in China. Unlike the SISS Pilot Study, the SES survey was not a part of the IEA SISS project. Nor has the SES data base been used by any international research organizations. Thus, the SES survey results can be employed as an independent source of information to reconfirm or disconfirm the aforementioned findings in comparative education.

It should be noted that IEA has launched a Third International Mathematics and Science Studies (TIMSS) project in the mid nineties. No empirical data have been released from this on-going project yet. Hence, the SES data analyzed in this research are the most recent and representative data available to the public. In addition, in spite of the dramatic economic growth in China, no political reform has taken place in recent years, and education has been constantly under government control. According to an official report from the 1994 National Education Conference in Beijing, major problems in the late 1980s remain

unsolved, and education in China must uphold the same principles addressed in Deng, Xiaoping's speech in 1985 (Bai, 1994). Therefore, the SES data collected through the IEA instrument in 1988 should maintain a high value of reference about current middle school science education in China.

In social sciences, repeated empirical investigations are indispensable steps toward a genuine understanding of the society (Best & Khan, 1993). Only those empirical results which were consistently reconfirmed by repeated studies should form the foundation of our understanding. Hence, even though the Third International Mathematics and Science Studies (TIMSS) is currently in process, analyses of the SES data are much needed to uncover more empirical findings for repeated reconfirmations in TIMSS and other studies in future.

Research Questions

Bloom (1975) maintained: "A major feature of the IEA is that its evaluation instruments and data-collection procedures have been developed especially for the purpose of international comparison and study" (p.66). To facilitate an international comparison, the instrument developed for The Second IEA Science Study (SISS) was employed in the SES survey in 1988. Because of this comparative feature, the U.S. SISS data collected by the same IEA test in 1986 were also employed in this study to assess if the 9th grade student science achievement was higher in China than in the United States. Questions that guide this research are:

1. Is the student science achievement higher in China than in the United States based on the SES and SISS data sets?

2. Are there any significant provincial differences of student science achievement in China?

3. How should the comparative results be interpreted in terms of the different school investment between urban and rural communities in China?

Methods

In 1987, shortly after the SES project was announced by the China State Commission of Education, seven provinces from five regions, West (Gansu and Sichuan), South (Guangxi*), Central (Hubei), North (InnerMongolia*), and East (Jiangshu and Liaoning), expressed interest to participate. The China IEA Center had no reason to exclude any of these provinces from this study. Hence, the survey was conducted over a random sample of around fifteen thousand 9th grade students in the seven provinces. Consequently, some regions had more than one province participated in this project, and a direct integration of the seven provinces may cause an unbalanced regional representation in the national data base.

To balance the regional representation, only one province from each region should be included in the national data base. Accordingly, in this study, the student data from five provinces, Gansu, Guangxi, Hubei, InnerMongolia, and Jiangshu, were employed to represent the five regions in China. The integrated national sample over the five provinces contains approximately 11,000 ninth grade students. The sample size was designed according to the student information from the SISS Pilot Studies.

Student achievement in science was measured in this study by a 30-item SISS tests. Development of the instruments was a collaborative effort of international educators,

* InnerMongolia and Guangxi autonomous regions are equivalent administration units of provinces.

including those from China and the United States. The American and Chinese student data measured by the same instrument were appended into an international data base, and the independent sample t test was employed to examine if differences of student science achievement between the two countries were significant at α=.05 level. Analysis of Variance (ANOVA) was subsequently adopted to test if provincial differences of student achievement were significant based on the Chinese SES data. In case the significant differences were identified, the Bonferroni post-hoc test was further employed to locate the provinces between which the differences occurred.

Results

Based on the comprehensive list of student enrollments developed in the SES population investigation, the Chinese 9th grade students were selected in SES through a two-stage stratified sampling process (Rosier, 1982). The U.S. student sample was selected in SISS by the Research Triangle Institute in North Carolina. The achieved sample sizes from the SISS project in U.S. and the SES project in China are listed in Table 1.

Table 1 inserted around here

Results of the t test are assembled in Table 2.

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Comparisons of the provincial differences are tabulated in Table 3.

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Discussion

Inspection of Table 2 suggested that the difference of student science achievement was insignificant between the U.S. and China. This result refutes the assertion of Chinese outperformance claimed by many scholars (e.g., Postlethwaite & Wiley, 1992; Stanley, 1989; Stevenson & Stigler, 1992). On the contrary, compared to the result in China, the average student score was slightly higher in the United States. Given the large sample sizes in both countries, this insignificant difference may result from randomization processes of the survey sampling.

The ANOVA results show that provincial differences of the student achievement in China were significant at α=.05 level (Table 3). This result seemed to indicate that students in different regions of China could have significantly different science achievement. The Bonferroni post hoc test reconfirmed this finding, and revealed that students in Hubei province scored significantly higher than their peers in other provinces. Differences in Chinese science achievement could be even larger between urban and rural schools. For urban areas, Deng (1995) reported:

> Middle school teachers also live better than before. The average monthly income for instructors at the Beijing Normal University Middle School is 900 yuan, and the figure is even higher for those with seniority. (p. 13)

While in rural areas, Deng (1995) wrote:

> This state of affairs is even worse for teachers in China's countryside, especially very remote areas. In many places they are unable to collect their salaries for several months at a time, and receive hardly anything in the way of allowances or benefits. (p. 14)

Deng's observation may have exposed a tip of the iceberg. Consequently, the substantial school difference among Chinese regions and communities is certainly one of the main reasons causing the "learning gap" inside China.

Torney-Purta (1990) pointed out: "Almost weekly, newspaper headlines remind us of the importance that American society places on the school achievement of its young people, especially in comparison to their peers in other countries." (p. 32) According to the empirical results presented in this paper, cautions ought to be exercised in those comparative studies regarding the Chinese student selection. Partial information from either side of the Chinese learning gap may result in an unfair international comparison, and hence, mislead newspaper headlines in the American society.

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Table 1: Sample Sizes of the SES and SISS surveys

	U.S. (SISS)	China (SES)				
		Gansu	Guangxi	Hubei	InnerMongolia	Jiangshu
Sample Size	2164	2376	2444	2998	2350	2616
Total	2164	12784				

Table 2: T Test -- Differences of Student Science Achievement between U.S. and China

Country	Mean	Standard Deviation	T Test
U.S.	16.779	4.872	T (14946) = .0294
China	16.776	4.429	p = .9766 > .05

Table 3: ANOVA -- Differences of Chinese Student Achievement Among the Five Provinces

Source	DF	Sum of Squares	F Value	P Value
Province	4	867.69610463	11.09	.0001
Error	12779	249891.4396119		
Summary	F (4, 12779) = 11.09; p = .0001 < .05			

	Post Hoc Test: Comparisons Significant at .05 level			
	Hubei-Gansu	Hubei-Guangxi	Hubei-InnerMongolia	Hubei-Jiangshu
Difference Between Means	.7533	.4082	.5986	.4225
Bonferroni Critical Value of Studentized Range = 3.858				